Recycled Smartdevices for Real-Time Monitoring of Civil Infrastructures

Arturo Buscarino[**], Carlo Famoso[*] and Luigi Fortuna [**]
[*]*Dipartimento di Ingegneria Elettrica Elettronica e Informatica, University of Catania, Italy*
[**]*IASI, Consiglio Nazionale delle Ricerche (CNR), Roma, Italy*

Abstract. This contribution summarizes some preliminary results obtained in the development of a platform based on recycle smartdevices to monitor the vibrations of buildings and infrastructure. The platform, designed within the framework of a project funded by the Italian Ministry of Economic Development, exploits the accelerometer, the other sensors and communication boards included in smartdevices which have reached their end-of-life. The idea is to realize a fully autonomous setup capable of acquiring information provided by the different sensors, store the datasets in a cloud server which can be accessed either during the monitoring phase or the post-processing phase, and perform locally a real-time nonlinear analysis to extract features leading to alarms.

Introduction

Essentially two types of monitoring are implemented, i.e. static monitoring, performed regularly in medium-long intervals and useful for the observation of quasi-static phenomena, and dynamic monitoring, providing continuously the information, with measurements performed at medium-short intervals, according to the phenomenon to be observed (seismic or windy episode). In this contribution, we outline a low-cost and green strategy to the realization of a reliable building monitoring based on unused smartdevices which are capable to provide the needed information with high reliability and with time constants and resolution comparable with a daily monitoring activity.
In the normal context of private or low-complexity buildings, a small number of monitoring station is required. In order to contain the costs of the platform, we referred to an extremely widespread technology, such as that present in smartdevices which, even if they contains properly working and reliable sensors, have completed for software compliance their life cycle. According to reliable estimates, about 350,000 smartphones are thrown away every day, and of these the vast majority are still functional and offer sensors, connectivity and the ability to process information on site [1].

Results and discussion

If properly placed in a site of the building, monitoring stations based on reused smartdevices allow to determine the acceleration to which that certain point of the structure is subjected. The most common accelerometers in smartphones are capacitive, equipped with Micro Electro-Mechanical Systems (MEMS) sensors. In some operating conditions, these accelerometers are more efficient in measuring constant accelerations linked to quasi-static phenomena than piezoelectric accelerometers. The post-processing of the raw data provided allows for the extrapolation of indirect information that helps to create a complete and comprehensive picture of the environment being monitored: speed, inclination, subsidence.
The prototype developed during the project is reported in Fig. 1(a). It consists in a box hosting a recycled smartphone and a battery which can be recharged by using solar panels.

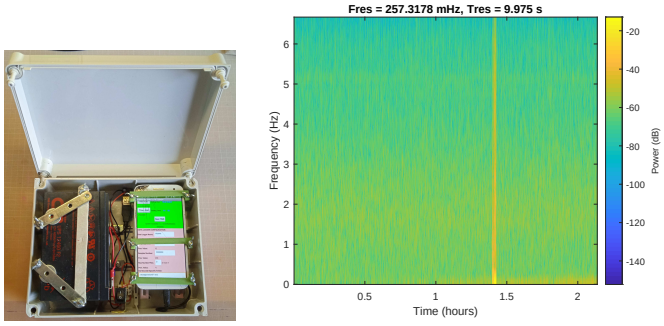

Figure 1: Experimental results: (a) Prototype of the monitoring box; (b) nonlinear spectrogram showing the onset of oscillations.

Preliminary measurements have been acquired considering two locations within a building: near one of the main piles and near the external walls of a room located in the upper floors. A nonlinear frequency analysis allowed to identify the onset of oscillations, as shown in Fig. 1(b) even considering a low accuracy in the sensor quantization, which are originally designed for sensing larger vibrations. This validates the system and allows for planning the next steps in the road-map which includes the monitoring of an old church bell tower.

References

[1] Bucolo, M., Buscarino, A., Famoso, C., Fortuna, L., and Gagliano, S. (2020). Automation of the Leonardo da Vinci machines. Machines, 8(3), 53.